Homework 1 Programming

5 Local Linearization Approach for Controlling CartPole

5.8.1

Here's a screenshot of the cost of the cartpole simulations.

```
case 0 average cost: 6.099334745518128
case 1 average cost: 142.46929107921534
case 2 average cost: 628.8893904717709
case 3 average cost: 1760.8614268947501
case 4 average cost: 4490.291114707545
case 5 average cost: inf
case 6 average cost: inf
case 7 average cost: inf
shreshth.rajan ~/school/cs184/pset1/lqr [main] $
```

The increase in cost across cases 0 to 7 makes both theoretical and intuitive sense. For any i [0, 7], case i corresponds to $[0\ 0\ 0.2i\ 0]^T$, where 0.2i is the angle of the pole in radians. As the pole's angle increases, the cost increases since the cart needs to shift away from the goal to make the pole upright, which is farther from the equilibrium state of being upright. The pole obviously has a nonzero angular velocity here and there will be an additional nonzero force exerted to make the pole balanced, which means it makes sense that later cases would have a greater cost. Once the pole's angle is greater than 1 radian, there's an infinite cost since the cart explodes to the right to catch the pole but is unable to, which results in the pole falling below a horizontal and not upright. The LQR's approximations should also get worse the farther the cart is from its goal state — as it does with the increase in angle, hence also why the cost increases.

5.8.2

```
cost = 2.81713633267038
```